PROFESSOR E. T. COX,

State Geologist, Indianapolis, Ind.:

DEAR SIR—I have the honor to submit, herewith, my Report on the Geology of Dearborn, Ohio and Switzerland counties.

Yours truly,

ROBERT B. WARDER.

CLEVES, OHIO, Dec. 1, 1872.

GEOLOGY

OF

Dearborn, Ohio and Switzerland Counties.

CHAPTER I. SURFACE FEATURES.

Dearborn, Ohio and Switzerland counties, all bordering on the Ohio river, present such similarity in structure and character that it is more appropriate to make a report of this district as a whole, than to describe each county separately.

This district extends forty-three miles from north to south, and twenty-one and a half miles from east to west. The area is as follows:

Dearborn county.....	186,311 acres,	291.11 square miles.
Ohio county.....	54,749 acres,	85.54 square miles.
Switzerland county...	143,053 acres,	221.96 square miles.
Total	383,113 acres,	598.61 square miles.

A line drawn from the mouth of the Kentucky river to Fort Recovery, Ohio, was the western boundary of the land ceded to the United States by the treaty of Greenville, Aug. 3, 1795. This line is known as the Old Indian Boundary, and separates Dearborn and Ohio counties from Ripley.

TOPOGRAPHY.

As we pass from the Ohio river to the higher parts of the district, we observe a pleasing variety of hill, valley and plain. On leaving the river bottoms and terraces, which are often a mile in width, we ascend the comparatively rugged, but fertile river hills, then pass over broken upland and reach the wet flats where there is often so little natural drainage that water stands on the surface under the oak and beech timber a great part of the year. Hence the local name *slash* given to such land, perhaps from the sound produced in walking over it. The rock formations of this district consists of layers that were originally deposited horizontally, and the Cincinnati uplift affected the whole district so uniformly that very little dip is observed. We can not therefore, attribute this variety of topographical features directly to any upheaval of the rocks, or dislocation of strata. Neither have I seen any marks of erosion that can be attributed to glacial action, unless the broad area occupied by the Miami bottoms and the adjoining terraces be so explained. The valleys must therefore have been formed by streams of water; that is, by the streams that now drain this part of the State, or by those that may have drained it in former ages. It is possible that some changes of the surface were wrought by the tides and currents as the continent was emerging from the ocean, but these agencies could only affect the higher parts, and have not been traced with any certainty.

There is such an intimate relationship between the topographical features and the characters of the soil and agriculture of the several parts of this district, that I have thought necessary to discuss the subject somewhat in detail. As the map will show, there is a portion of flat upland embracing a district near the water-shed, between the Whitewater River and other tributaries of the Ohio on the east, and Laughery creek on the west. A similar area stretches nearly across the north part of Switzerland county. Much of this land is less flat than a similar part of Ripley county, but

still retains the waters, especially in the native timber, and merits the usual appellation of "White Oak Slash." The most level fields are on the highest ground, forming the water-sheds between the several creeks. As we leave the water-sheds the ground becomes more and more uneven, till by imperceptible degrees we reach the *broken upland.* This will average at a considerably lower level than the flats, but is still high ground; the water here accumulates with sufficient force to wash the soil very badly, if care is not taken to prevent it. The next belt represented on the map includes a still more broken area, which we will term the *hillsides.* These rise abruptly from the river terraces, but can not be distinguished by any rigidly defined boundary from the broken upland. From the "white oak slash" or "crawfish flats," the ravines gradually become deeper, the general surface becomes lower, and the slopes become steeper toward the river and creeks. The base of the hill is very distinctly marked; the other topographical boundaries are selected as the most convenient to present the facts, but they must not be regarded as representing definite lines of demarkation.

The amount and character of erosion displayed in the valleys depends upon the nature of the material to be worn, the amount of water in the stream, and the amount of its fall in a given distance. The larger streams have been acting with such force that a considerable part of their course is now below high water mark of the Ohio River. The points reached by the backwater of 1847, in the larger creeks, are marked on the map. The rivulets that rise on the upland, within a mile or two of the river bottoms, have a fall that enables them to cut deep ravines and make the surface very hilly. The parts farthest removed from the rivers and large creeks, are least affected by erosion, and retain much of the original character of the plain.

It has been suggested that part of the Miami valley may be due to glacial action. This view is supported, besides other circumstances, by the comparative width and the direct course of the area of low land lying on the Whitewater in Hamilton county, Ohio, and on the Miami below

its junction with that stream. If this is the correct theory, the glacial valley extended at least as far west as Lawrenceburg, and it is remarkable that there is a deep surface valley in Kentucky, from above Petersburg to nearly opposite the mouth of Laughery creek. This Kentucky valley is narrower than that of the Miami, with which it corresponds in position and course. At the lower end is a mass of cemented gravel, about 150 feet in hight, commonly called "Split Rock." Similar masses occur below. The hypothesis naturally suggests itself that the valley may be a continuation of the glacial valley described above, and "Split Rock" part of the terminal morain. Slabs of blue limestone occur among the gravel, as though torn from the beds by the advancing glacier.

A table of elevations has been prepared from such data as I could command* Rigid accuracy can not be expected, even when elevations were obtained by an engineer's level, since all the hights were not measursd from a common base. I have assumed the surveys of the Ohio and Mississippi Railroad to be correct, as the base was determined with great care from canal levels. According to these data, low water at Cincinnati is about 410 feet above the sea level.

I have selected prominent points from the upland; the elevations refer to tide water.

FLATS.

Summit of grade near Sunman, Ripley county, 1,007 feet, obtained by the Indianapolis, Cincinnati and Lafayette Railroad level.

Summit of grade near Milan, Ripley county, 1,000 feet, obtained by the Ohio and Mississippi Railroad level.

*I am indebted to the engineers of the Indianapolis, Cincinnati and Lafayette and Ohio and Mississippi Railroad Companies for the use of profiles; and to Messrs. E. M. LeClerc, U. P. Schenk and Grisard, of Vevay, Mr. J. M. Froman, Mr. M. G. Keeney, of Florence, and Mr. Nathan North, of Millersburg, for the use of turnpike profiles and tables of Switzerland county.

General level of high ground in northwest part of Switzerland county, 950 feet, obtained by Aneroid barometer.

Moorefield, 885 feet, obtained by turnpike level.

High point near schoolhouse, one mile south of East Enterprise, 910 feet, obtained by turnpike level.

Quercus Grove, 870 feet, obtained by turnpike level.

BROKEN LAND.

Dillsborough, 785 feet.

High points, southwest part Switzerland county, 875 feet, obtained by Aneroid barometer.

Ridge, south of Guilford, 775 feet, obtained by Aneroid barometer.

"Seminary Hill," near Vevay, 700 feet.†

RELATIONS OF TOPOGRAPHY TO HISTORY, ETC.

Topographical features bear an intimate relation to the engineering of roads and railroads, and therefore to the histories of these counties. In laying out a road from the low land on the river, towards the interior, advantage is often taken of the broad creek valleys, to secure an easy grade, and give an outlet to the fertile bottoms and hillsides. Convenient access to most of the high land, however, is gained by locating the roads on the various ridges that slope towards the river. Here were constructed the principal thoroughfares across these and adjoining counties, and here sprang up many small towns, as Yorkville, Mooreshill, and Dillsborough. When the railroads were afterwards made across Dearborn county, with an ascent of 500 feet, an easier grade was required; and to gain this, the valleys of the Tanner's and South Hogan creeks were selected. Much of the travel was thus diverted from the ridge roads, town property ceased to increase in value, or even depreciated; and in one village there is now no tavern where two were once supported.

†The elevation of this point above the river at Vevay is 304 feet, as obtained by Mr. C. G. Bœrner, to whom I am indebted, also, for other assistance.

I can not leave this topic without a remark upon the character of the scenery, which indeed is a very important geological feature. The blue limestone region presents no perpendicular cliffs.* Cataracts also are incompatible with the nature of the rock. Where the ground is uneven, the hills are beautifully rounded, the ridges gracefully sloping to the bottoms, or marked by "saddle-backs." There is no grandeur in the view to fill the mind with awe, but there is a tranquil beauty in the contour of hill and valley, there is a certain loveliness in the aspect of the river, slumbering on the bosom of the rich alluvial terraces, that inspires the mind with thoughts of peace and rest. Even where the ground becomes more level, a vista of four or five miles may be enjoyed from favored spots.

STREAMS AND WATER POWER.

Each county fronts on the Ohio river, and is drained by the tributaries of that stream. The Miami river touches the southeast corner of Dearborn county, and the Whitewater flows through the northeast part. Tanner's creek empties into the Ohio near Lawrenceburg. North and South Hogan creeks unite in Aurora, near their mouth. Laughery creek flows southward through Ripley county, then southeast, forming the boundary between Dearborn and Ohio counties. The streams of Switzerland county are comparatively small; the principal are Grant's, Bryant's, Log Lick, and Indian creeks.

These streams give efficient drainage (usually towards the southeast) except in some parts of the upland flats and a few spots on the terraces. The valley of Laughery creek, divides our district into two natural divisions, as a study of the topography shows; for the flood of 1847, reached a point five or six miles from Ripley county.

The great amount of fall in many of the streams, early suggested the value of the water power, which has been utilized in many places. The flow of water, however, is so

*One exception is noted in chap. i.

uncertain, that many of the mills can run but part of the year; and as this difficulty has increased, many of them have been abandoned. There is abundant testimony that the summer streams are less constant now than they were some years ago. This change may be attributed to clearing the wet highlands and their more speedy drainage in the spring, rather than to an actual change in the climate. Since the fields have been cleared and plowed, also, much of the water is absorbed by the soil and given up again by evaporation, that would otherwise have flowed off to the creeks.

RISE AND FALL OF THE OHIO RIVER.

The annual floods of this stream are subject to great range of variation, both in the amount of rise and the time of year at which the maximum is reached. The record kept at Cincinnati Water Works for the years 1859 to 1871, inclusive, shows that the highest water for the several years has occurred in each of the winter and spring months, and the lowest water in each of the summer and fall months except June. The water in the channel has fallen, in each of these years, as low as five feet eight inches, and has risen as high as forty feet six inches. The river stood at two feet four inches, Nov. 1, 1862. Two feet six inches is called "low water mark." The most remarkable floods of which we have definite records, occurred in February, 1832 and December, 1847. These floods were sixty-two feet above low water, and the level then reached is generally called high water mark. Floods of 1792 and 1815, are supposed to have been about five feet lower.* The highest stage of the river since 1848, was fifty-five feet above low water, reached in January, 1862. The highest floods of this century have thus occurred at intervals of fifteen and seventeen years. If such a periodicity is established by a longer series of observations, it must indicate the recurrence of climatic conditions, favorable for an accumulation of water at one time.

*See Howe's *Historical Collections of Ohio*, p. 224.

SPRINGS AND WELLS.

Good springs are abundant in nearly all parts of this district. Water is generally found in wells at a depth of fifteen to thirty feet. Both spring and well waters are hard from the underlying limestone. Comparatively soft water occurs in the upland drift, as at Milan, Ripley county, and this is preferred for locomotive engines.

Several farmers assert that the number of good springs has increased since these counties were first settled.

There are two springs that have some reputation for alleged medicinal properties. One of these, belonging to Lazarus Cheek, is one-fourth of a mile northeast of Aurora. The water is clear, slightly effervescent, and smells strongly in summer of sulphuretted hydrogen. It is recommended as a tonic, purgative and diuretic. The water issues from the base of the hill, close to the river bottom, and seems to proceed from the native marl, which abounds at this place almost to the exclusion of limestone. A cistern near by was so affected by sulphur water as to be useless. In Switzerland county, almost in the bed of Grant's creek, a few miles from its mouth, is another spring of some repute for supposed medicinal virtue. This water also smells strongly of sulphuretted hydrogen, and I am told that the gas emitted will burn about a minute if a lighted match is held near. Whether the reputed value of these springs is real or imaginary, I leave for the consideration of the medical profession.

Several other springs, tainted with sulphur and disagreeable salts, occur on the high land as well as low land.

A well was sunk at Aurora by Messrs. Gaff & Baughman, through—

Gravel, sand and clay, about	90 ft.
Blue limestone and clay, about	130 ft.
Total	220 ft.

It is stated that at 160 to 170 feet down, a vein of salt water was found, the quantity of brine, however, being too

small for economic purposes. Mr. Drayton's analysis gives, from eight ounces of water:

Salt	115 grains.
Lime	2 grains.
Sulphur and magnesia	2 grains.
Total	119 grains.

This is equivalent to about three per cent. of solid matter, but as the brine was diluted with water used in working the diamond drill, the pure brine may have been stronger.

A dozen or two salt licks and brackish wells have been noted, chiefly on low ground, near the principal creeks. The manufacture of salt will be referred to in the chapter on economical geology.

Near Laughery creek and elsewhere are a few springs tinged with iron; some have an oily scum, which is sometimes mistaken for a sign of petroleum.

CHAPTER II. DESCRIPTIVE GEOLOGY.

GEOLOGICAL FORMATIONS.

The prevailing rocks are Lower Silurian. The Upper Silurian deposits occupy small areas in the northwest parts of Dearborn and Switzerland counties. The dip is hardly appreciable, except in the western part. There is drift on the uplands, and the river terraces consist of modified drift.

LOWER SILURIAN.

These rocks form part of the "Cincinnati uplift." Their usual character has already been described in Dr. Haymond's report on Franklin county, and in the Geological Reports of Ohio. In almost any of the quarries, or escarpments of rock, the blue limestone is seen interstratified with blue marl or clay. The proportion of limestone varies with the locality, but usually not more than one-third the whole bulk is suitable for economic purposes.

The limestone seldom occurs in layers of more than eight inches. There is an apparent layer of sixteen inches in the Lawrenceburg quarry, but it is separated into two or three by partings of clay. Neither does the marl occur in uninterrupted beds of any great thickness. Near Rising Sun there is an exposure of twenty feet, or more, of blue clay, with no limestone more than an inch or two thick: but even here, there is a very thin layer of solid rock at every foot or few inches. The blue limestone is broken by vertical joints at intervals of a few feet or less. The largest piece observed was at Vevay, about ten by six feet. The pieces often approximate to the parallelogram in shape; sometimes this feature is very striking, where the layer is divided into bits by two sets of nearly parallel joints, not running at right angles. A weathered stone often exhibits very narrow parallel grooves on the upper surface. By breaking the specimen they are seen to extend through one-fourth, more or less, of its thickness.

A peculiar form of rock is seen in certain layers whose under surface is almost plain but the upper surface is waved, being crossed by gently curved ridges, two or three feet apart. There is a fine exhibition of this peculiarity near the junction of Bain's branch with Grant's creek, Switzerland county. The layer is 6 inches thick at a ridge, and $1\frac{1}{2}$ to $3\frac{1}{2}$ inches at the depression, being thinnest where the ridges are furthest apart. The overlying stratum of marl fills the space between the ridges, and the next layer of rock is as even as usual. The arrangement of the ridges may be compared to that of a honeycomb in an old fashioned bee-hive. Where one ridge terminates, those adjoining on each side approach each other until the usual distance is restored.

Compact concretions, or mudstones of oblate form, are common in the shale, being most numerous with certain layers.

The freshly quarried rock has a pale blue color and somewhat crystaline fracture. It is usually fossiliferous, and when made up of large shells it often has too open a texture

to withstand the action of the weather. Water penetrates the stone, disintegration begins and irregular partings appear. Some layers are more compact and almost destitute of fossils. These are of a deeper color if freshly quarried, but both kinds, by exposure, become a whitish-gray on the surface. Iron pyrites occur in one or two layers of solid limestone in some localities, and is sometimes mistaken for an indication of gold. Most of the limestone is firm and durable but can not be dressed to a handsome surface. The blue clay is fine-grained and easily cut with a knife; it has a shaly cleavage in the direction of the layers. A smooth or freshly cut surface, when held in the sunshine, shows a beautiful iridescence. It crumbles or "slacks" on exposure and soon produces a fertile soil. Yellow clay takes the place of the blue in the upper part of the series.

The following analysis is from the Ohio Geological Report for 1870, page 460.

BLUE LIMESTONE MARL, WAYNESVILLE, OHIO.

Silicious matter	69.60
Alumina and sesqui-oxide of iron	10.24
Carbonate of lime	12.55
Carbonate of magnesia	1.91
Potash and soda	5.40
Phosphoric acid	0.16
Total	99.86

At the quarries near St. Leon, Dearborn county, in the upper part of the series, the rock is compact and bears hammer dressing much better than the average rock of this formation. On exposure it becomes gray. This change begins at the surface, and gradually reaches the center. While this is in progress, the two colors are not blended, but the gray and the blue remain very distinct.

Some peculiarities in lithological structure occur in the Log Lick and East Enterprise turnpike cuts according to the following section:

No. 1. Fossiliferous blue limestone and clay..... 10 ft.
No. 2. Compact gray and blue limestone and clay... 11 ft.
No. 3. Compact, in small pieces, limestone and clay.. 6 ft.
No. 4. Fossiliferous blue limestone and clay of usual character..... ....

No. 1 includes little that is unusual.

No. 2 resembles the rock near St. Leon. It is gray near the surface, and dark blue at the center. One layer consisted of long pointed pieces, about one foot by six feet, with clay between in the same layer.

The layers of stone in No. 3 consists of pieces from two to eight inches in diameter, set close together. The larger pieces break without showing a fresh surface, and scarcely a sharp corner.

No. 4 extends, probably, to the level of the river. The top of the section is four hundred and forty feet above low water. The absence of *Rhynchonella increbescens*, *Streptalasma* and *Petraia corniculum* seems to indicate that these rocks are not at the top of the series.

Another peculiar form is seen in certain heavy layers of limestone exposed near the Ohio river opposite Carrollton. Beginning about two hundred and fifty feet above low water mark, we have the following section of rock without the usual joints and almost destitute of the marl that is elsewhere interstratified with the limestone:

No. 1. Hard limestone, weathered so as to show numerous layers..... 4 ft. 0 in.
No. 2. Harder limestone, in places showing no further division into layers..... 4 ft. 6 in.
No. 3. Like No. 1..... 10 ft. 8 in.
No. 4. Like No. 2..... 4 ft. 4 in.
No. 5. Like No. 1..... 5 ft. 0 in.

Nos. 2 and 4 sometimes form overhanging ledges.

Calcareous tufa, inclosing recent *Helices*, is formed in the cavern. These beds may be traced two or three miles on the south face of the hills. Large masses that have rolled down the hillside show that the rock is very firm. The

position of these rocks, and their fossils induce me to consider them Lower Silurian, in spite of their anomalous lithological character.

Among the lowest Lower Silurian rocks exposed are layers of compact stone of comparatively dark color and abounding in fossils. This rock crops out in Millersburg, one mile from Florence, and at other points on the river. The stone is quarried nearly opposite Rising Sun, at low water, and used for tombstones under the name of "Kentucky marble." It receives a beautiful polish, when the fossils are very distinct; some dull spots probably indicate the position of concretions through the rock. Small cavities lined with calc spar sometimes occur and small crystals of iron pyrites are frequent. Slabs are quarried as large as desired.

In different parts of the series, thin layers occur which have a sand-like texture and a rusty or brown color. Some specimens are almost as fissile as shale, and are found adhering to the usual form of limestone.

In the railroad cut above Weisburg there is an exposure of about ten feet of loose yellow sandy material. This bed contains one ten-inch layer that is pale, blue and pretty firm in the center, but is yellow and crumbling near the upper and lower surfaces. Other thin layers occur similar to the upper and lower parts of the one just described, besides one-half inch of crystalline blue limestone. Some clayey layers also occur. This is equivalent to the rocks described as the upper beds of the Cincinnati group in the Ohio Geological Reports for 1869, page 147, and 1870, page 267, and by Prof. E. Orton, provisionally regarded as equivalent to the Medina sandstone of New York. (Ohio Geological Report for 1870, page 268.) Some of the wells near Weisburg show a blue rock of sandy texture, easily cut with a knife, which is probably the same deposit, unchanged by the decomposing action of frost, air and water. Similar rock is found in wells in Ripley county, northwest of Dillsborough, and in the northwest part of Switzerland county, also in the quarry of Mr Hotchkiss, near Bennington, who has shown

it to possess hydraulic properties. The *Favistella stellata* (which, according to Prof. Owen, marks the upper limit of the Lower Silurian) was not found in the section at Weisburg, but occurred one or two miles south of Mr. Hotchkiss' quarry at a somewhat lower level.

Nearly all parts of this series abound in fossils, but only the lower order of animals and plants are represented. Specimens from various localities have been sent to the State Geologist for identification. By studying these relics we learn that during the ages that were occupied in building up this formation, many changes occurred in the life of the ocean-world. The thimble trilobite (*Trinucleus concentricus*) abounded in the earlier part of this age, but was afterward very rare. The star coral, (*Constellaria stellata*), and other fosssils, are confined to certain horizons, while the upper fossiliferous beds are distinctly marked by the *Rhynchonella increbescens* and *Streptoplasma corniculum*. Numerous parasites flourished, as the *Tentaculites flexuosa*.

The exact equivalent of these rocks with those of New York is hard to determine. We have many fossils that are catalogued by Professor Hall, some as characteristic of the Trenton, and others of the Hudson period. Some of the species seem to have a wider range here than is indicated in the New York Reports.

UPPER SILURIAN.

The characteristic fossils are the safest means of distinguishing the several periods of geological history, but well preserved specimens are so rare in the Upper Silurian rocks of Dearborn and Switzerland counties that I was compelled to rely upon the lithological character and the position of the strata to distinguish them from the rocks below. This formation does not appear in Ohio county, but overlies the Lower Silurian in two small areas which are separated from each other by the valley of Laughery creek.

There are good exposures of the weathered rock between Weisburg and Van Wedden Station. Some firm layers occur one foot or more in thickness. Intermediate with these are softer limestone and shales.

The exposures in Ripley county, on the Ohio & Mississippi Railroad, between Laughery creek and Osgood, show the same general character. One layer of 21 inches is there quarried; but where the heavier layers crop out, they generally weather so as to disclose one or more partings. The *Favistella* occurs below these rocks. Near the top of the section, within a mile of Osgood, the limestone and shale have all the lithological characters usually seen in the Lower Silurian, and contain *Orthis Lynx*, *Streptoplasma corniculum*, and other fossils. Further west are quarries of bluish stone, buff on the surface, and similar to the rock shipped from Laurel, Franklin county.

Mr. Hotchkiss' quarry near Bennington, Switzerland county, shows several thick layers of limestone, separated by layers of clay not more than three inches thick. The stone is often gray, but the deep blue color in the quarried stone as well as the gray of weathered specimens, are sometimes more decided than in the Lower Silurian. There are several outcrops in Switzerland county of a very hard buff limestone, containing crystals of calc spar. This layer is several feet thick. It contains *Orthis Lynx*, *Strophomena depressa*, *S. filitexta*, and a few other fossils, and is probably the highest layer in the county, but may be entirely local.

Tetradium and *Favistella* are exposed by a small creek in Ripley county, southeast quarter of section 32, township 6, range 12 east.

POST TERTIARY.

There are no deposits that have been indentified as belonging to this period, but the bones of extinct animals have been found at several places imbedded in clay or gravel. These generally occur in the low land bordering the Ohio River or large creeks, and in some cases are clearly in the drift, being exposed by the gradual wear of the river bank. The following is a list of the instances:

Mastodon and Mammoth. Part of a pelvis was found at a salt spring on Tanner's creek below Guilford, and a tusk on Laughery creek above Hartford. A tooth was found at

Rising Sun, in the river bank. A piece of a femur and other fragments were taken from a gravel bank at the mouth of Grant's creek. Mr. M. R. Green, near Patriot, informs me that a piece of tusk five or six feet long, somewhat curved, and about six inches in diameter, was found in the river bank near his house. A Mastodon tusk, fourteen feet long, was found in the river bottom, five miles below Vevay. A Mastodon tooth was found on high ground on George Randall's farm, five miles west-southwest from Aurora. It was lying on a stratum of bluish clay, eight or nine feet from the surface.

Dr. Lutton, of Aurora, has a skull of the large black bear, found in clay at Aurora. He has also a bone that closely resembles that of the Irish Elk. Dr. J. W. Baxter, of Vevay, says that the bones of a sloth were found in the drift above the mouth of Bryant's creek. These bones and teeth are nowhere so abundant in my Geological district as on Big Bone creek, Ky., where they are imbedded in stiff clay and well preserved.

Our study of these remains is rendered difficult by the scarcity and fragmentary character of specimens. Whenever indications are seen of a good specimen, the greatest care should be taken not to disturb it until everything is in readiness to do the work thoroughly; then every piece should be carefully removed, cleaned, and subjected to some process to preserve it from the disintegration that very speedily ensues if the bone is exposed to the air without this precaution.

DRIFT.

There is more or less drift on nearly all the high land. Northwest of Manchester, at Fairview, and in other parts of the upland flats, the limestone is overlaid with unstratified blue clay, containing pebbles and bowlders, many of which bear glacial scratches. The impervious nature of this clay determines, to a great extent, the agricultural character of the "crawfish flats." Much of the drift has been removed by erosion from the broken upland, but even

on the hills, some pebbles are found (occasionally scratched) which must be referred to this source. Bowlders are common in each of the counties, some of them three or four feet in diameter.

An interesting specimen, found near Tanner's creek below Weisburg, was a piece of native copper, weighing twenty-six ounces, which must have been brought by natural agencies from the Lake Superior region.

An unusual amount of pebbly drift occurs on the hills near Florence, and at the base is a mass of clay mingled with pebbles, on which no scratches were observed.

At Hartford, there is a remarkable accumulation of drift, chiefly resting against the north face of the native hill. Between the bottoms of Laughery creek, and the hilltop, the deposit is about two hundred feet high, with a beautiful grassy surface, divided by narrow dells. An outcrop through the soil shows nothing but cemented gravel. Time has been wasted here in searching for lead. Sand, with some cemented layers, was found near the top. At the base are slabs of blue and gray limestone, mingled with clay, a variety of pebbles, and flattened ferruginous concretions, which consist of concentric layers or are hollow. A trilobite (*Calymene*) with the form and markings uninjured was here associated with scratched pebbles. In one of the prospect holes there is about twelve feet of quicksand in a basin of native rock. Large crystalline bowlders abound south and southwest of Hartford, occupying a space one mile east and west by one-fourth mile north and south, in a valley that opens towards Laughery creek. Two or three small streams flow northward across this valley to the creek.

Chemical changes have taken place in the material of the drift, since it was deposited. Cemented gravel occurs at Hartford and was found in a well near Van Wedden's Station. Split Rock, Ky., is thoroughly cemented by lime and the same change has taken place in many parts of the river terraces. The bog ore described under economical geology, is deposited from the waters of ferruginous springs. A similar substance, but whiter and of limited extent, occurs

in the "crawfish soil" near East Enterprise, and in a clay terrace near Hickman's Landing. Small hard smooth ferruginous nodules occur in parts of the upland flats, where they are said to dull the plow. Brittle concretions, one to three inches in diameter, similar to those at Hartford already described, occur on broken upland one mile west of New Alsace. Radiating crystals of carbonate of lime, almost transparent, but stained to a pale yellow, occur at Hartford, at the base of the drift, adhering to gravel and to limestone.

A phenomenon of interest, but quite local, is the occurrence of vegetable remains in the drift. Mr. N. Van Osdel gave me the following section of his well, in the broken upland of Ohio county, northwest quarter section, 6, township 3, range 2 west:

Soil and clay	22 ft. 0 in.
Yellow sand, quite hard or cemented..	9 ft. 0 in.
Blue clay, quite hard, without pebbles.	1 ft. 6 in.
Rotten leaves, twigs, black soil, wood (believed to be walnut), and thick bark	1 ft. 6 in.
Coarse sand, gravel and shelly stone...	9 ft. 0 in.
Hard blue limestone	1 ft. 0 in.
	44 ft. 6 in.

Similar deposits occur on gently rolling upland, in the northwest part of Switzerland county. The most interesting of these is at Mr. J. B. Gordon's, in section 4, township 5, range 12 east. The section as described to me is as follows:

Soil, clay, etc., more whitish at the lower part	22 ft. 0 in.
Blue mud, resembling recent alluvium	6 ft. 0 in.
Black soil containing leaves, cedar wood and ochreous particles	3 ft. 0 in.
Small stones packed together like a Macadamized road	1 ft. 0 in.
	32 ft. 0 in.

The bottom layer would be called "rotten limestone," if found in a quarry, and is probably native rock. Several wells in the vicinity are said to have furnished specimens of wood, etc., and one near Aaron Postoffice, some leaves and poplar bark at a depth of 32 feet.

West of the ridge on which Mr. Gordon lives, the rock is much nearer the surface than it is on the east. At a depth of 10 to 14 feet in the well, ledges of rock were projecting on the west side only, while no rock was found in the old well 25 feet further east. These ledges are of a sandy texture, and yellow except a narrow blue portion at the center. They closely resemble a layer, already described, from the Weisburg section, and like it, have probably been peroxidized. Buried vegetation is found in Highland county, Ohio, and many other places. That disclosed in these wells may be of similar origin.

Modified drift is described in the next article.

RIVER TERRACES.

The Ohio river, its bed, and the adjoining lowlands, have been the subject of very interesting changes, especially as the agencies are still in operation, producing results that can be observed from year to year. The Ohio, as proved by borings at several points, "runs in a valley which has been cut nowhere less than 150 feet below the present river." [See Ohio Geological Report for 1869, p. 26.] The many tributaries have since brought down gravel, sand, clay and mud, thus filling up the valley to the present level of the river bed and the adjoining lowlands. The source of this deposit is to be found in the several formations, including drift, over which the river and its affluents have flowed. The deposit, or at least the upper part, exhibits a stratified arrangement, and is called modified drift.

Let us first consider the surface features. The river flowing from one side of this area of lowland to the other, is even more winding than the valley of erosion prepared for it. The bottoms extend on both sides of the river. except at intervals where the water strikes the native Silurian rock

and is deflected in the opposite direction. The aggregate width of the river and lowlands, within the district we are considering, is usually from one and a half to two miles.

The lowland generally consists of a series of terraces,* rising from the river to the hillside, of native limestone; and the whole area varies in width at every mile as the river passes toward either shore. The terraces vary in number, hight, and slope, conforming to no apparent law. For convenience, they may be classed as high and low terraces, and gravelly knolls. No correspondence is observed in the hight of the terraces on the opposite sides of the river. More than half of this lowland area is included in the high terraces, which rise above high water. The surface may be gently rolling, and is often divided by a low water shed parallel with the river, the greater part being drained toward the hill, at the base of which is the channel of a wet-weather stream. The greater part of the low terraces are subject to overflow in time of the highest floods. They often slope toward the river, and under favorable circumstances those which are subject to frequent overflow receive an additional deposit of rich alluvium.

Low terraces sometimes occupy nearly the whole space from the river to the hillsides; for example, at the mouth of Plum creek and the first mile below; at Florence, and at the mouth of Bryant's creek, and the first mile above. In the first instance, the high terrace lies on the west, separated by a well marked bench, while the low terrace is reduced in width to a few rods, and entirely disappears below the warehouse at Vevay. The same features are presented at Florence, most of the area between the lower part of Log Lick creek and the Ohio being occupied by high terraces. The low terraces at the mouth of Bryant's creek extend west to a point where the river strikes the native rock, but are reduced to a very narrow strip on the east, where they are bounded by high terraces. Such variations, as well as others, may be noted throughout the river portion of the

*The river bottoms are all included in this term..

district we are considering. At one place, a terrace presents an unbroken surface of gentle and uniform slope. Either above or below, the surface may separate into two or more terraces, one being from two to twenty feet higher than the other. A terrace may have a gradual slope in the same direction as the river current, or in the opposite direction. I have seen no instances of such regularity as represented in the view of the Connecticut river terrace in Dana's Manual of Geology.

At or near the base of the limestone hillsides, gravelly or sandy knolls and ridges occur at certain places. These are higher than any of the terraces described, and present a more uneven surface. Examples will be seen north of Rising Sun, and near the mouth of Plum creek.

If we observe the material of which these deposits consist, we find a great variety; limestones, sandstones and shales are mingled with various crystalline rocks. All kinds of rocks that are common in the Ohio valley are here represented. Fair specimens of certain corals sometimes occur. Coarse and fine sands are interstratified with gravel, sometimes with clay. The gravel beds are often cemented where they are exposed or near the surface. It is noticeable, also, that the higher terraces are older, and consist of coarser material than the lower ones.* This is seen where a section of a high terrace and adjoining low terrace are exposed together, as at Vevay. Five to fifteen feet near the surface is generally sandy, resulting in part from the decomposition of coarser material. With this exception, the high terrace contains coarse gravel and bowlders through the whole depth as far as exposed, while the low terrace at the same level contains finer material only. The lowest terraces consist of the very fine loam deposited by recent floods.

While a half dozen terraces can be distinguished on some parts of the Ohio, its tributaries do not exhibit so many. Two are distinctly marked on parts of Laughery, Hogan

*For this observation and other aid in studying this subject, I am indebted to Hitchcock's "Illustrations of Surface Geology."

and Indian creeks. The larger creek channels have been eroded much deeper than their present level, and have since been filled by material brought down by the several streams, chiefly a whitish clay, with traces of stratification. A well near Laughery creek, (two and a half miles from its mouth) disclosed a bed of water-bearing sand at a depth of forty-seven feet.

Other materials than those described occur in this formation. At Lawrenceburg, exposed only at low water, is a bed of blue clay, containing abundant remains of leaves and logs.* The fruit of the buckeye, beech, hickory and buttonwood were recognized. This deposit of organic remains was found also in a Lawrenceburg well. Limbs and pieces of wood imbedded in blue clay were found in a well at Aurora. An excellent exposure of similar character occurs at Hickman's Landing, Switzerland county, two miles above Florence. A bed of blue clay containing leaves and wood, four and a half feet thick, may be traced in the river bank without interruption for twenty rods, and appears at points above and below. Both here and at Lawrenceburg there are ochreous deposits of sand or gravel above and below the clay. At Hickman's Landing these layers are usually cemented, and some thin layers of similar character are interstratified with the clay. The greater part of this terrace (which slopes towards Sand Run) was covered by the floods of 1832 and 1847. At a point near the river, about four feet above those floods, a well was dug reaching the bed described, showing that this is not a recent deposit upon the shore, but it must be older than the terrace which contains it. Another boring disclosed the bed more than a quarter of a mile from the river. Some antiquarian remains now form part of the terraces. In the river bottom, below the mouth of Laughery creek, are the remains of ancient fireplaces. One of these disclosed by the wearing away of the bank was thirteen feet below the surface of the river bottom. Deposits of mussel shells are exposed in the banks

* This was pointed out to me in 1871, by Prof. E. Orton, of Ohio.

near Florence, from three to ten feet from the surface. These point out the presence of man while those terraces were forming.

Having thus described the present condition of this formation, it will be necessary to study the changes that are now in progress, before framing any theory of geological history. The chief agent is the river itself, now rushing down with a flood of water fifty feet deep, and a few months hence gently flowing with but three or four feet in the channel. Here the current strikes the loose gravel or sand of the bank, and the wind drives the waves against the shore; there the swollen waters have spread beyond their banks, the current is arrested in a shallow place, and particles of fine sand and clay, leaves and vegetable mould, are deposited to enrich the bottom, or to help form a new terrace. In certain places large portions of either high or low terraces become undermined and slip into the water. The united action of frost and wind carry on the same work of destruction. Elsewhere the farmers are extending their cornfields where the waters formerly flowed.

A few examples of these changes will be given: At Rising Sun it is estimated that no less than three hundred feet of the bank has been washed away within twenty-five years. A row of houses has disappeared which once stood above Main street, with road and play-ground beyond. The well referred to, at Hickman's Landing, was dug about one hundred feet from the bank, but it has been carried away and much of the bottom behind it. At Florence there was but little wear twenty-five years ago, the bank being protected by trees. About eighty feet of the bank have been lost at the Main street within a few years, and two hundred feet a short distance below. Repeated changes of the river road have been required in many places.

The process of land making is also very common, but I judge that the amount of material deposited will by no means equal the amount removed. There was formerly a low island above Vevay, close to the Indiana shore. Steamboats ascending the river frequently passed through the

chute, twenty years ago. The steamer Kentucky went through as late as 1859. A few tow-heads were gradually formed about the upper end. The current was thus arrested and the fine material held in suspension was deposited. When this accumulation had so filled the chute that the island was connected with the main land at low water it became part of Indiana; another corn field has been added to the agricultural wealth of the State. A stump, which was at the water's edge in 1850, to which the fisherman fastened his net, is now several rods from the bank. Land is still forming among the trees beyond and below the island. Similar deposits are generally forming wherever a growth of willows or other trees is secured sufficient to diminish the current in time of overflows. Sometimes, however, the exposed roots of trees indicate that they are not a certain preventive of erosion. The current may be even wearing the bottom at one point while depositing silt immediately beyond. For practical suggestions on the protection of river property, see the chapter on Agricultural Geology.

Let us now consider what hypotheses will most readily account for the observed facts. We will assume, with most geologists, that the drift phenomena prove a "glacial period," when the continent was raised far above its present level. This period preceded the formation of the terraces; beside other proof, this is indicated by the variety of the material, for the terraces contain crystalline bowlders from the drift as well as sedimentary rocks that are native in the Ohio valley. During the elevation of the continent, the erosive power of the Ohio and its tributaries would be augmented by the increased amount of fall in the streams. This easily accounts for the wear of the rock formations to the depth required below the present river bed.

During the "Champlain Epoch" which followed, the continent subsided, the force of the current diminished, and the coarse material brought down by the stream was deposited. This process must have continued till the highest parts of the present terraces were reached by the flood. The creeks, meanwhile, left a deposit of clay from the Silurian hillsides.

The terraces have not yet been accounted for. The river bed is now far below its former level, and we must call to our aid one more period of continental rise to explain the erosion that followed the Champlain Epoch. Whether this part of the continent is still rising has not been determined by historic data, but we have seen that the "Terrace Epoch" is not yet at an end. Partly by the erosion of the river at certain places while deposits were forming at others, and partly by the agency of tributaries, the ever changing series of terraces may be accounted for. The hight at any point will depend simply upon the amount of erosion and the depth of deposit. As already noticed, the high terrace has entirely disappeared near the mouth of several of the creeks. The material that has been worked over and re-deposited is finer than that of the original formation, as noted at Vevay; but we may not always be able to determine whether a certain bottom should be referred to this epoch, or to a denuded part of the original deposit. During this epoch or the preceding, soil was formed, and various trees flourished such as are now common in temperate regions. These remains are not found through the whole deposit, because either their growth or the conditions for preserving them were local; but it will be observed that the deposit at Lawrenceburg is twenty or thirty feet below that at Hickman's Landing, and could not have been made at the same time. The antiquity of the vegetable remains in these instances is argued from the overlying deposit. That at Hickman's Landing was made at a time when not only could the river rise four feet higher than the greatest floods of historic times, but the circumstances were favorable for the formation of river bottom at this hight. Wood and leaves are still buried every year by the alluvium, and may be unearthed in the future. The old channel at Vevay island is now occupied by a pile of drift-wood. By the operations now in progress, this may be completely covered and preserved. A future race, digging a well on the river bottom, may find the same phenomena that interested us ten miles above.

Professor Hitchcock's conclusion, drawn from the study of terraces elsewhere, is equally applicable here. The successive terraces, he says, "may be found by the simple drainage of the country, as the surface emerges from the ocean. Nor need we, as has generally been thought necessary, suppose that there were pauses in the vertical movement."

(Illustration of Surface Geology, p. 58.)

RECENT GEOLOGICAL CHANGES.

The line between geological and historical times can not always be distinguished; the "Terrace Epoch," as we have seen, includes the present time. Whenever a flood washes the soil from the hillside, or tears up the stone from the brook, the process of erosion is in progress. The frost, the rain, sunshine and plant-growth, still carry on the work of soil-making, just as in prehistoric time. The calcareous tufa of Switzerland county, while regarded as a recent formation, is governed by the law of chemical geology.

Another interesting phenomenon is the formation of sink-holes. These are most abundant in the soils overlying the Upper Silurian rocks, or the upper part of the Lower Silurian, where the water sinking through the soil wears away a channel by dissolving the rock, and the soil, no longer supported, falls in. A very common form is that of an inverted hollow cone. This may increase, if the water is allowed to wash down more and more of the soil to the channel below, but if it becomes sodded over, (especially when filled with brush or rubbish), the wash may be arrested, and the sink be converted into a pond, and gradually filled up.

When the surface soil is matted together by the roots of grass, it will keep its place long after the cavity has begun to form, until finally some horse puts his hoof upon the fragile roofing, and a cavity is revealed large enough to hide the whole animal. The next year the hole may be filled.

A series of sink-holes sometimes points out the vein of water, when a well is to be sunk, or an opening in a layer of rock, when a quarry is to be opened.

A common phenomenon is the land-slip, especially on the steep river hills. The clay, being wet with spring rains, becomes slippery and too soft to support the weight above. Part of the hillside slips down by its own weight, forming a bench where the material accumulates. A greater depth of soil is retained on the benches than on the steeper part of the slope.

ANTIQUITIES.

Dr. G. Sutton, of Aurora, kindly promised to furnish an account of the antiquities of Dearborn county, and these will not be considered in this article.

Artificial mounds, as well as darts and other implements, are numerous in Ohio and Switzerland counties, near the Ohio river and Laughery creek. They are often associated with burial places, either in the bottom or on commanding eminences. I have found no mounds on the upland flats, though other relics sometimes occur, as a beautiful heart-shaped ornament of Huronian shale, found near Bennington.

Dr. J. W. Baxter, of Vevay, gives me the following account of a series of mounds or signal stations, occupying prominent points along the Ohio river, and so located that each may be seen from the next above and below. These command nearly the whole bottom. From the station below Patriot the observer may look across Gallatin county, Kentucky, and the valley of Eagle creek to the hight of land in Owen county. Both this mound and one near Rising Sun exhibit traces of fires that were doubtless used as telegraphic signals by the Mound Builders. The mounds at the following places form a complete series, though others may have been used when the country was timbered:

Rising Sun.
Near Gunpowder creek, Kentucky.
The Dibble Farm, two miles south of Patriot.
The "North Hill," below Warsaw, Kentucky.
The Taylor Farm, below Log Lick creek.
Opposite Carrollton, Kentucky.
Below Carrollton.

A greater number of wild grapes, plums, crabapples and onions are found near the mounds than elsewhere.

Dr. Baxter refers these relics to the same race as the natives of Central America, from the similarity of hieroglyphics on pottery found near Warsaw, and from the features of a face carved in sandstone from the same locality.

The fireplaces, near the mouth of Laughery creek, have been mentioned in describing the river terraces. These are disclosed from time to time as the river wears the bank. Dr. Grant, of Kentucky, told me he had known at least eight. The one I examined consisted of a layer of bowlders 13 feet from the surface. The part exposed was 3 feet across. Pieces of charcoal, soft and crumbling, were found among and under the bowlders, while other pieces, that had fallen out and dried in the sunshine, were firm. The clay under the bowlders was red as though burnt. No one could examine the section without being convinced of human agency in the work.

In the river bank, opposite Florence, there it a layer of decomposing mussel shells, thirty-two inches from the surface. The outcrop now extends forty feet, and was noticed as early as 1847, when the bank stood two or three rods further towards the channel than it now does. This deposit seems to be entirely local, though extending over several square rods. The shells include Unios, such as are still common in the river, and are so far decomposed that the laminated structure is plainly marked, as in shells that have been burnt. Similar deposits have been observed elsewhere in the terraces.

CHAPTER III.—ECONOMIC GEOLOGY.

BUILDING STONE.

The blue limestone is everywhere abundant, and is well adapted for foundations, cellar walls and other rough masonry. Very little of it will bear dressing. Houses made of this stone may be substantial, but are not handsome; they be-

come discolored with age, and sometimes stained with iron; stones of coarse texture weather badly. Few quarries are extensively worked, because the stone may be picked up from every creek, or dug out of almost every hillside. This limestone is less liable, than the Cliff, to split and fall to pieces under the action of fire. J. R. Kilner, of Lawrenceburg, pointed out an illustration of this fact in the foundation of an old warehouse near the I. C. & L. depot. The building was burnt, with about one hundred tons of hay and many thousand empty barrels, but the rock foundations suffered little injury. Large slabs of compact stone are selected for fireplaces, and last fifty or sixty years. The smaller stones are much nsed for Macadamizing roads where gravel can not be obtained.

The so-called "Kentucky marble," used for monuments, has been described.

Quarries near St. Leon and Weisburg furnish a superior stone, approaching that of the Upper Silurian in color and compactness. This stone resembles that of Schrichte's quarry, near Brookville, described in the Report for 1869, p. 181.

The Upper Silurian quarry of George A. Hotchkiss, near Bennington, furnishes excellent building stone, which was used in the jail at Vevay. A difference is observed among the several parts of the quarry: the stone from one layer having been tested for nearly twenty years is scarcely affected by exposure. The stone is grey on the surface, but is often of a dark blue color when broken. It is compact, and contains few fossils. A similar stone occurs in Dearborn county, one mile south southwest of Mooreshill, and is quarried near Elrod, Ripley county. Both these localities furnished stone for the bridges of the Ohio & Mississippi Railroad.

LIME.

Lime is burned for home consumption, in temporary kilns or in "log heaps." If the latter method is selected, the stone is laid on a pile of logs (the large pieces being

broken) and burned about one day. When the fuel is exhausted, although the stone is not all thoroughly burnt, some good lime is made. This method requires several times the quantity of wood needed in the kiln, and is now more seldom resorted to, since timber has become less abundant. There are no perpetual kilns. The blue limestone from the surface or the creeks is generally used. This makes a dark colored but strong lime, well suited for mortar, though it will not answer for the skim, or for whitewashing. The same kind of lime is used by soap manufacturers in Cincinnati to prepare the caustic lye. The dark blue compact layers produce a much whiter lime than the fossiliferous rock.

HYDRAULIC CEMENT

Has been made by Mr. Hotchkiss, near Bennington, from the lower layers of his quarry. This stone resembles in general appearance the massive beds at Madison, lying above the *Favistella* layer. It seems to be the geological equivalent of these beds and of similar outcrops near Weisburg, but there are no fossils to prove the identity. It is a pale blue stone, turning greenish on exposure to the weather. The lowest layer that has been worked is darker. There are some irregular streaks of hard limestone, especially in the upper layers, which underlie the building stone. On burning it becomes greyish yellow, and the ground cement, when pressed with the finger, has a glossy appearance. It hardens more quickly under water than in the air. A specimen mixed with half its weight of sand, and made into a cake three-eighths of an inch thick upon a piece of stone and immersed in water, was hard, and had a perfect gloss at the end of fourteen hours. Mr. Hotchkiss says the cement does not check in drying, and that it sets under water in fifteen minutes, and the continued action of water for some months only seems to harden it. It adheres strongly to stone. Specimens may be seen on outside stone work that have been exposed to the weather since the fall of 1871, and seem to become harder with age. The distance of the quarry

from a railroad or the river is one of the chief difficulties in the way of establishing manufactures at this place on a large scale.

A similar stone crops out at various points near the junction of the upper and lower *Silurian* in Jefferson, Switzerland, Ripley and Dearborn counties, but no satisfactory tests have been made within my district, except at the locality specified. Further experiments should be made to prove its durability and its fitness for cisterns. Still more satisfactory results may be obtained by burning the stone for a longer time, or with a more regular heat than could be maintained in the kilns used.

BRICK, FIRE CLAY, ETC.

Bricks consist essentially of clay, moulded into convenient form and hardened by drying and burning. Pure clay will warp and crack. A certain proportion of sand is needed to make the clay porous, and let the moisture escape from the interior of the mass. Too large a proportion of sand makes the brick fusible. Pebbles of any kind are to be avoided, and little pieces of limestone are especially injurious, as they are converted into quick lime, and when the bricks are wet this absorbs moisture and swells, breaking the brick.

Suitable material for brick making occurs in most parts of these counties. There is a brick-yard at New Alsace, on the yellow clay of the broken upland. The "crawfish" clay of the upland flats near Enterprize, is used, but is rather too tough. Among the terraces there is a variety of material from which to select. At Newtown, the recent alluvium is used, mixed with a due proportion of sand or sandy loam. At Rising Sun, the material is taken from an older terrace. The upper part contains too little sand; but a suitable proportion is found at a depth of ten feet, and the clay at six feet, answers well when mixed with that from below. An old lime-kiln, a section of which is now exposed in the bank, distinctly shows the action of heat on the several parts. The clay wall at the bottom is still hard and firm;

but as the sand diminishes towards the upper, part the wall becomes more and more crumbling.

A blue fire-clay occurs in Mr. Hotchkiss' quarry, in layers of three inches and less. It turns yellow on burning. Where the river terrace slopes toward the hill, as at Vevay, a stiff blue clay sometimes occurs, which may be derived from the native marl washed from the hillside. This mixed with sand is recommended for setting grates. It is said to be better for steamboat furnaces than genuine fire-clay.

Red pottery-ware was made at Vevay fifty years ago. Yellow-ware was also made near Rising Sun, and stoneware from blue clay on Arnold's creek; but these manufacturers were long since abandened

Drain-tile is made at Sunman's, Ripley County, and near Madison. For this purpose a purer clay is required than for brick. A premium was offered by the Switzerland and Ohio Counties Agricultural Association, for the establishment of this industry in either of these counties, If the demand should warrant the enterprize, suitable clay can be found at certain places.

GRAVEL

Suitable for roads is found at many places in the river terraces, including those of the Whitewater and Miami. No suitable deposits are accessible on the high land.

MOULDING SAND

For heavy work is procured from the railroad cut near Newtown. Kettles eighty-four inches in diameter are cast by Mr. Stedman, of Aurora, in the green sand; for light work this is mixed with sand from the Ohio River.

SALT.

The manufacture of salt was carried on in early times, when transportation was difficult; but this industry was long since abandoned, as there are no salt wells or springs

strong enough to make it profitable. There was a government reservation kept for this purpose on section 25, township 6, range 1 west. Salt was made in the early part of this century on Grant's creek, at the mineral springs already described—ten or twelve kettles used. The Indians are said to have made salt at this place. Several bushels were made in 1840–42, in Jefferson county, from a boring on section 12, township 5, range 11 east. Borings of about 200 or 250 feet were made at Hartford, with no satisfactory results. It is said that thirty gallons of water from a salt lick in Dearborn county, near Hartford, were evaporated by Mr. Wilber and produced nearly four pounds of salt, which was pretty good, but yellowish. Salt was obtained from a boring at Jacksonville, Switzerland county, but the brine was too weak to be profitable.

FERTILIZERS.

There is an abundance of limestone which can be cheaply burned. No beds of gypsum are found.

There is a small quagmire near Hartford, rich in decaying organic matter, which may prove to be valuable.

The blue marl which is interstratified with the limestone, contains a good proportion of phosphates, and Dr. Locke, of Ohio, says it would be a valuable fertilizer.

Mr. Drayton and Col. Mitchell, of Aurora, propose to manufacture a phosphate, for agricultural purposes, from the blue clay or limestone of that locality.

Remarks on the use of fertilizers will be found under Agricultural Geology.

IRON ORE.

Good bog ore occurs in many parts of the broken upland, but has not been seen elsewhere. In each spot it seems confined to a few rods or a few acres near the hilltop, but several outcrops occur near one locality, as near Quercus Grove. There are ledges from six to fourteen inches thick, but the stratum is seldom continuous, being divided into pieces a yard or less in diameter. Drift pebbles occur

through the mass in many cases. The ore is most frequently noticed at the surface, or where struck by the plow, but it has been seen eight or nine feet deep. No great depth is to be expected, as the limestone occurs below. In one or two localities the soil is barren, but farmers generally say they observe no difference in this respect. If the ore exists in sufficient quantities near good shipping points, it may prove valuable.

The principal localities in Dearborn county, are near Guilford, and Dillsborough; in Ohio county, on James Kittle's farm, section 5, township 3, range 2 west; on A. Barrecklow's, section 30, township 4, range 1 west, and on Benjamin Miller's farm, near Rising Sun; in Switzerland county, on several farms near Quercus Grove, and several farms northwest and northeast of Vevay.

LEAD.

There are traditions that the Indians gathered the ore by the apron full, and pieces of galena have been picked up in various places, but no vein has been discovered, and I have seen no specimen known to belong to this geological district. The long continued unsuccessful search has proved that no workable ore is to be found. Some of my inquiries ended in such information as this: A says that B said that a certain person thought he could point out the mine!

GOLD.

Dr. Dorsey of Hartford, examined the drift of that region, and found one small particle of gold from two panfuls of sand. Ohio county, is not destitute of this widely disseminated metal, though it does not occur in any paying quantity.

CHAPTER IV.—AGRICULTURAL GEOLOGY.

While this subject is properly one branch of economical geology, its importance demands a separate chapter, which will be devoted especially to the interests of the farmer.

Agriculture is eminently a matter of experience, yet there are certain underlying principles that should be understood in order that the farmer may avail himself of the experience of his brother farmer, who is laboring on a different kind of soil, with different topographical features, different crops, or a different climate. This chapter will embrace some applications of geological truths to the most important industry of this district, and if I step beyond the limits of strict geological science, I trust the effort to make this report a work of practical value will be a sufficient excuse.

The carpenter acquaints himself with his tools, and the various kinds of wood; the iron smelter studies his ores, fluxes and coals, and the agriculturist can not understand too well the nature of the soil from which he would gather his harvests, the changes that are wrought by cultivation, and the most successful means of preserving or increasing its fertility. While the blue limestone region is not rich in mineral wealth, the soils of this district are among the most productive in the State.

DESCRIPTION OF THE SOILS.

A good soil must have certain properties in order to afford a suitable support for the roots and stem of the plant, to furnish the needed food and to bring this within reach of the plant. If it is very light and sandy, the soil may be blown away from the roots, leaving them bare and without sufficient support; the rains, penetrating too quickly, may sink away and be lost, or may evaporate too fast, leaving the crop to perish for lack of moisture. A close, stiff clay soil allows the water to pass through with difficulty; much flows off from the surface. When thoroughly wet, evaporation goes on slowly; it remains wet and is slowly warmed by the heat of the sun. The roots can not penetrate so far as they should in search of food. Several kinds of plant food are always required. The ingredients that are most often lacking (besides moisture) are potash, lime, phosphates, and the products of decomposing organic matter. Some of these

substances exist naturally in small proportions, and by constant cropping the amount becomes too limited to produce good crops.

To describe fully every variety of soil in a single township would require more space than can be allowed to this whole report. A single farm of half a section, may include part of a rich bottom that has just received its annual deposit from the river, a dry gravel terrace, a cold wet clay terrace and rich black hillsides. Even on the same acre, the best of the soil may wash from the poor gravelly red ridges, where the wheat is hardly worth cutting, and enrich the lower parts, which are clothed with a luxuriant growth of grain. While there is such a diversity on every side, there are some prominent features that are most abundant in certain sections. If this district were divided with respect to the prevailing character of the soils, the boundaries would nearly correspond with those laid down on the map to distinguish the topographical character of the several parts. The properties of a soil are observed in handling a specimen, working the field or noting the agricultural products, but we also want to know its origin, the amount of slope and the aspect, or direction of the slope. The erosion to which the land has been subjected may influence its character, and the native timber is a good index of its quality.

The typical soil of the upland flats is derived from true drift, with which it is underlaid. It consists chiefly of stiff, cold, wet clay, of ashen color. Water stands on the surface after a rain. The soil is shallow, for it is too stiff and close to let the roots and moisture penetrate readily. The subsoil, when wet, is very sticky ; it adheres to the spade like putty. When dry, it is very hard, the spade will not penetrate it. The ground near the watersheds is called *crawfish* land from the abundance of these animals. Their holes retain water all summer. Where there is more natural drainage, this is not the case. Towards the broken land, in all directions, the soil is more yellow and mellow, and appears to have a larger proportion of sand. This is seen on the surface after a rain, when a rill that has accumulated the sand, spreads

out over a more level space, and dropping the sand, carries the clay beyond. The subsoil, in many places, is a mixture of yellow and bluish clay, with more or less sand. In the northwest part of Switzerland county, fragments of chert are very common, thinning out and disappearing a few miles from Jefferson county.* In some parts of the flats, especially on the wet spots, the hard ferruginous pebbles or concretions abound, referred to in describing the drift.

The prevailing timber of the upland flats varies with the nature of the surface. White Oak and Beach abound. Other oaks, several kinds of Hickory, Black Gum, and Dog wood are common. Poplar, Walnut and some Sassafras, grow near the breaks.

On the broken upland the amount of drift varies according to the thickness of the original deposit and the amount lost by erosion. The limestone and marl add to the fertility where they are exposed to the air or streams. In some parts the rock crops out at the surface, in others there are many drift pebbles, the clay having been removed; in still others, the digging of wells shows the true, unmodified drift. These soils are yellow, except where a large amount of organic matter has accumulated, as in the native forest or by the use of green manure. Although the vegetable mould is generally more abundant on the hillsides than here, yet this soil has the advantage of retaining the moisture better than that which is darker and more mellow.

Sugar Maple, Black Walnut, White Walnut, Beech, Hickory, White Oak, Linden, Elm, and Red bud are common species of timber.

The still more broken land, including the hillsides, contains in the blue limestone formation all the mineral ingredients essential to perpetual fertility, but these must be modified by disintegration and the addition of organic matter, before they can be appropriated by the plant. Some steep, barren hillsides are practically worthless. Having

*The cherty feature, which must be attributed to Niagara rocks, is strikingly exhibited in a railroad cut east of Osgood, Ripley county.

been cleared, or bearing but little timber, they do not support even a good crop of weeds. The soil is washed off as fast as it is formed. In more favored localities a thin white clay soil accumulates, sufficient to produce a scanty crop of wheat. In still others, the forest leaves are mingled with the soil, or a crop of clover has been plowed in, furnishing the organic matter that is needed to make the rich. "black hillsides." Note the fertile slopes near Rising Sun, where the hills are covered with a garland of trees. A farm on Grant's creek produced satisfactory crops of corn and wheat for fifty years, when it was thought necessary to restore the land simply by raising hay. This is not an exceptional instance, for the hillside farmers claim that a proper rotation alone is necessary to maintain the fertility unimpaired. As every crop taken from the field withdraws some potash phosphates and other plant food, it must not be supposed that the same soil will yield undiminished crops. Every rain washes something from the surface toward the creeks, the water takes up carbonate of lime from the surface of the rock, and every rootlet that penetrates the marl below aids the frost and sunshine in the process of soil making. Thus the field undergoes a constant renovation, and it is the abundant supply of food stored up in the underlying marl and limestone that give this region its inexhaustible fertility.

The southern exposure is generally regarded as the most fertile, though abounding in loose stones. One farmer says the eastern slope is better for wheat than the western, since the crop receives the benefit of the morning sun and is less apt to rust.

Black Locust and Honey Locust are specially characteristic of the limestone soil. Several Oaks, Ash, Beech, Elm, buckeye, Linden, Wild Cherry, Hackberry and Mulberry also abound. Walnut and Sugar Maple are indicative of rich soil.

The terrace soils remain to be described, which are derived entirely from modified drift and material washed from the several formations of the Ohio valley. The

ingredients are so varied that no essential mineral element is wanting. The creek deposits derived from the blue limestone resemble the hillside soil, in being stiff, clayey and whiteish wherever the organic matter is exhausted, but with this ingredient the creek soil is very similar to the rich, black hillsides.

The gravel of the river terraces would easily admit the air and rain, and quickly yield to these decomposing agencies, producing good land. Some terraces contain gravel only a foot below the surface, in others the soil is deep. There may be an understratum of coarse or fine gravel, or even of fine clay. Some river terraces are very sandy, as the low bottom above Rising Sun. Some are stiff and clayey, as a narrow strip on the north side of the Sand Run; this may be attributed to material washed from the hillsides. The recent river deposits are always fertile, and where a frequent addition of river mud can be secured, no apprehension is entertained that the land will be exhausted.

Willow, Elm and Buttonwood grow near the streams. Soft Maple, Oak, Poplar, Walnut, Hickory, Hackberry, Ash and Buckeye are also native to this soil. Beech, here as elsewhere, indicates a clayey soil. The Black Locust, though abundant on some of the gravel terraces, was probably introduced by man and has since retained its hold.

CROPS.

The chief field crops are corn, potatoes, wheat, timothy, clover, oats, barley, rye and onions. Fruit is raised in all parts, and a few of the farmers give some attention to timber planting.

Corn is especially adapted to the rich bottoms, as these receive frequent additions of rich alluvium from the overflowing river. The crop is sometimes destroyed in these localities by late floods. The higher bottoms, which are not so rich in vegetable matter, are well adapted to wheat. Potatoes and the various grains are extensively raised in all parts except the upland flats. Switzerland county is noted

for the amount of timothy shipped for the southern market. It is estimated that fifteen thousand tons were exported from September 1st, 1871, to July 1st, 1872. The upland flats are better adapted to hay than to cereals. Good crops of timothy are raised, but this grass is crowded out in a few years by red-top, (*Agrostis vulgaris*) which in turn gives place to wire grass, (*Poa compressa*) and others. By proper culture and rotation one good crop of wheat or corn may be raised every few years. Clover is raised to advantage on the more mellow broken land. There is a larger proportion of clover in Dearborn than in Switzerland county, since this is quite as profitable as timothy for home use, and the facilities for shipping south from Dearborn county are not so good. Some onions are exported from Switzerland county.

The fruits most extensively raised are apples, peaches, plums (usually the Damson) and cherries. Pears, quinces and small frults are also raised, especially for home use. Success depends upon a proper location, to avoid frost, quite as much as upon the nature of the soil. High rolling ground is preferred, since the colder air sinks by its greater specific gravity into the lowest place within reach, and the high points are not subject to the same degree of cold as the neighboring low places. Good apples are raised even on the "crawfish flats," especially on the highest points. On the river bottoms, good fruit is sometimes produced (as in 1871,) when killed by frost on the adjoining hills. In this case it was probably protected by fog.

Timber planting has not received the attention it deserves. Black Locust grows quickly, and will produce a crop of good fence posts with some firewood every fifteen years. Farmers object to its proneness to send up suckers on the adjoining ground; but they may be kept within bounds in groves on rough ground near the ravines, or on the steep hillsides that are worthless for other purposes. The trees should be four to six feet apart each way. If this course is followed, a fertile soil may accumulate on the barren slopes, when they are shaded by the trees and receive the addition

of leaves each year. The cedar thrives on stony bluffs, and is recommended for such places; the larch has also been tried elsewhere if not in this district, and promises to be a profitable tree. Oak, Poplar and Walnut require at least a century to reach their full development, but future generations will require timber, and their needs should be regarded as well as our own.

PRACTICAL SUGGESTIONS ON HUSBANDRY.

The farmer's habits of observation enable him quickly to detect a field of natural fertility that has been *worn out.* By bad management it has been so changed that it will produce but one-half or one-third the crop that was raised on the virgin soil. The products are the criterion, rather than the appearance of the soil. By careful and judicious culture, on the other hand, the exhausted farm, or one not generally fertile, may be so improved as to yield double or quadruple crops. The changes, whether of deterioration or restoration, will depend upon the natural condition of the ground, the crops raised, and all those methods of treating the soil and crops that are embraced in the term, *husbandry.* I have sought to use every opportunity to converse with intelligent farmers and learn the methods they have used, the effects of such treatment and the systems which their experience enables them to recommend for this particular district. It is almost amusing to note difference of opinion on some of the simplest questions. One says that timothy improves the land; another, who is differently situated, that it deteriorates it, and that it was once as easy to raise two tons per acre as it now is to raise one ton on the same ground. One farmer recommends trench plowing, his crops having been improved by it; another tried it on the upland and years were necessary for the ground to recover its former productiveness.

The soil may lose its fertility, as we have seen, by taking the products off the farm each year, leaving less plant food in the ground for the next crop. This process has been carried on in a great part of this district. Some of the upland

has been exhausted by raising corn so that now it is difficult to get grass well set. The timothy crop has been impoverishing the soil more slowly, but not less certainly. It is estimated by chemical analyses that an average ton of timothy hay contains:

Potash	40 lbs.
Lime	13 lbs.
Phosphoric acid	15 lbs.
Other mineral substances	74 lbs.
	142 lbs.

Although 142 pounds of mineral substance may seem a small matter to take from a half acre of ground, it must be remembered that some of these ingredients exist in very small proportions in the soil, and only a small part of these may be in a soluble condition ready to be taken up by the moisture and given to the plant. Is there any means to supply this deficiency? Some improvement is generally made where clover is sowed, especially if the green crop is plowed in. The vegetable matter, even of the roots, tends the loosen the soil, and admit the air and moisture to bring a new quantity of phosphates, etc., into a soluble condition. Another plan, recommended for exhausted yellow soil of the upland, is to sow a crop of rye in the fall, clover in the spring, and turn in a drove of hogs in September for pasture. The rye will seed itself for the second year, when the hogs should be turned in again. Plowing in green manure and pasturing the ground are alike insufficient to add any mineral substance to the soil, and the most natural remedy is to use some fertilizer which will replace the elements removed. Stable manure is highly prized, and should be carefully husbanded; such a rotation is recommended that part of the farm be occupied by corn or wheat each year, and that these crops receive the manure. Rotten straw has been plowed under with satisfactory results. I am told that the improvement could be observed eight or ten years afterwards. Other fertilizers are needed to restore what is sold from the farm, and actual experiment alone will determine

what is best adapted to the several conditions. A few experiments have been tried with lime, plaster of Paris, and other artificial fertilizers, but as a record has seldom been kept of the actual cost and of the probable improvement by increasing the crops, a great difference of opinion exists concerning the practical money result. A farmer's deliberate opinions deserves all due respect, but a strong prejudice seems to prevail among some who have never tried any fertilizer, that just as long as they can clear a margin beyond their expenses, the use of artificial manures is throwing money away.

Many farmers have told me that they see the increased growth of weeds or grass near a limekiln, or where a log-heap was burnt. This observation is insufficient, however, to *prove* the value of *lime*, since the improvement may be due to the lime, or to the ashes which are rich in potash, and are known to be beneficial. A few farmers have applied lime to the soil, and generally have expressed themselves well pleased with the result; but an excess is injurious. One farmer tried twenty to twenty-five bushels to the acre with no apparent benefit. Although limestone abounds in the underlying beds, this does not crop out on all parts of the surface, and even where it does the lime is more easily dissolved and seems to be more effective as a stimulant for the plant. A plan tried near Quercus Grove is to moisten the seed corn and roll it in a mixture of lime and tar. This process is believed to improve the growth of the corn, as well as to protect the seed from some of its insect enemies, and the expense is trifling.

Land plaster, or uncalcined ground gypsum, is advantageous, especially for clover, and through this crop it benefits those which follow it.

An artificial fertilizer containing phosphate of lime has been tried with success in Dearborn county, but it should be used with moderation; an excess destroyed a crop of corn.

The remarks on fertilizers apply especially to the uplands, but similar needs exist in the high terraces of both rivers and creeks. Deep plowing, or even trench plowing, is

recommended here to bring up a subsoil that will easily become fertile by exposure. On the upland flats this is not practicable, because the subsoil, if brought to the surface, is not fitted to produce good crops without years of weathering. It is very possible that plowing one or two inches deeper than has been customary would not injure the surface soil, but would improve it by adding a new supply of potash, phosphates, etc. If barnyard manure or a crop of green clover is plowed under at the same time, it would be a great help in mellowing the stiff clay. After a few years the plow might be put still deeper, thus taking advantage of such resources as have been lying idle, though close at hand. It is probable that this land would be improved by *subsoiling*, or loosening the subsoil to a depth of a foot or more, without bringing it to the surface.

The flats are much improved by drainage. The commonest and cheapest way to effect this is to leave an open furrow at every two or three rods. This will only carry off the surface water, and the furrows require constant attention, besides occupying a considerable part of the land. Another plan is to lay poles in trenches, and cover them with earth. These make a sufficient outlet for water and do good service. The best and most satisfactory method is to lay drain tile. Mr. U. H. Stow, near East Enterprise, has tested the value of underdrainage on crawfish land, though the cost of bringing the tiles from Jefferson county adds materially to the expense. Mr. Stow says that drains three feet deep and six rods apart will be a great benefit. Apple trees, when drained, do not fail to produce good crops, and grapes send out their roots for rods, following the moisture.

Though the hillsides can be used indefinitely without fertilizers, they are liable to be injured by washing. Care must be taken on this account not to raise corn too long on broken ground, without a proper rotation of small grains or hay to allow the vegetable matter to accumulate. Pastures should not be cropped so close as to leave the ground bare, for when the gulleys take possession of the land it is a very expensive matter to reclaim it. The use of the "hillside

plow" is also strongly recommended, for if the field is plowed "round and round," part of each furrow will be up and down hill, and help the rains to carry off the soil.

The effect of shade, as a means of restoration, is illustrated on the farm of Mr. Givens, near Florence. A stony point, on which no soil had accumulated for several years, was covered with a pile of rubbish. When the evaporation of moisture was thus arrested, some blue grass seed that had lodged there germinated, and soon the plant was established. In three years the ground was well set with a natural growth of blue grass, and a soil had accumulated that could not easily wash off.

If a piece of clay is kneeded in the fingers, and placed in the sun to dry, it becomes hard. The same condition is seen in the surface of a road, when the mud has been worked by wheels and then dries. If clay soil is plowed while wet, a similar change takes place, it "bakes" and the roots can not so easily penetrate; if seed has recently been sown, the tender shoot has a hard crust overhead between it and daylight. The tramping of hoofs is apt to produce the same result, and the best farmers will not pasture a meadow from which they expect to cut a crop of hay.

The loss of river property by the wearing away of the bank is so serious as to demand prompt action. Paving and riprap are confined to the towns, on account of the expense. Brushwood, thrown over the bank and weighted down with stones, does good service in breaking the force of the waves and current when the river is high. The best means of meeting the difficulty is to encourage the growth of willows and other trees on the slope. Much injury has been done by clearing the native timber close to the water's edge. Willows grow readily on any part of the shore that is not too stony, provided that they can be protected from the cattle for three years. It is difficult for individual farmers to fence out the stock, as the water would wash away the fences required at a low stage. If cattle were kept away entirely, either by law or by mutual agreement, willows would quickly spring up in many places where they are now kept down by

the browsing of cattle. Willows have been planted out at various points with very satisfactory results. Mr. George Hickman, above Florence, recommends that some elms be set out with the willows. The willow cuttings should be put in as early as possible, as the winter or spring flood goes down, that they may be well rooted before the summer drouth. When the willows are cut off, they quickly grow up, and Mr. Golay, near Vevay, finds that he can use one-third of the crop each year for baling hay, without interfering with the primary object of the trees.

A rill flowing over the edge of a high terrace, as that below Vevay, very easily washes the loose gravel so as to do much damage in a single season. Care should be taken to control the drainage so that the water will have as little erosive force as possible. This is accomplshed by conducting the stream away from the bank and down a gradual slope, or by putting in a trough to convey the water beyond the gravel bank.

EXPERIMENTS.

Now to my friends who are engaged in agriculture, allow me to express the wish that you may adopt such plans as will make the occupation profitable, and not only so, but that it may pay you the richest rewards of which it is capable. You desire to realize the largest possible profits, with the least necessary expenditure. But if a farm nets $10.00 per acre when a profit of $20.00 or $30.00 is within reach, is not this poor management? It would be bad financiering to lend money at 6 per cent. when 8 per cent. can be obtained with good security. You have learned the importance of using the most improved implements, is it not equally essential to adopt the very best system of rotation, management and use of manures? Be assured of this that *it will pay* to adopt the very best methods, since the best methods are those which in the long run make the best returns; but many questions, yet to be decided, are included in this, what are the best methods? Our knowledge of botany and chemistry is founded on experiment and

observation. If agriculture is to maintain its ground with the advancing sciences, this also must be aided by judicious experiments. The more care is needed in this case, since we have to deal with the varying conditions of soil, location and climate; while proximity to market and the capital that can be invested will affect the practical results. While experimental stations are established at various agricultural colleges, to do this work with great accuracy, some simple experiments may be conducted here, to elicit new facts for the benefit of these regions of drift and blue limestone. These may be conducted by individuals or through the agricultural societies. To be of value they must be planned to determine but *one thing at a time.* For instance, if it is desired to know whether the wheat crop on a certain kind of land would be benefitted by the use of lime, select a field as nearly uniform as possible, sow a certain quantity of lime, as ten or twenty bushels per acre, on one-half the ground, sow the grain evenly over the whole field, and treat both parts exactly alike. After the harvest, measure and weigh the wheat from each part of the field, and see which has been the most productive. If there is any difference in favor of the lime, calculate from the ruling price of wheat, the net proceeds for this year of the money invested in lime. The experiment is not yet complete, for the lime is not exhausted in a single year. Whatever rotation is adopted, keep watch of that field, and record the results from year to year; note how long the benefit of the lime can be observed. In practice, it may be better to add a small quantity of lime year by year.

It is with no thought of slighting the labors of those farmers who have tried experiments that I make these suggestions for more accurate investigations. Something has already been done, but it is only by such patient and accurate work that you can satisfy yourselves *how much* benefit you can expect from any plans that may be recommended. By patient, laborious experiments alone, can we hope to reach anything like true scientific agriculture. Although the trouble and expense of working by weight

and measure may not be rewarded by a proportionate increase of the crop in every instance, yet this is our means of studying nature. Even as an intellectual occupation, this is delightful; how much more when you may hope to realize new truths that will benefit the whole community, and you are studying the operations of Him who "gave us rain from heaven and fruitful seasons, filling our hearts with food and gladness."

ACKOWLEDGEMENTS.

I can not close this report without returning my sincere thanks to all who have kindly given their aid in the labor of collecting the facts now presented to the public.

Besides the favors received from those whose names occur in the body of the report, I am indebted to the officers of each county for the use of maps and other information; to President Martin, of Mooreshill College, for access to the cabinet; to Messrs. G. W. Morse and T. E. Alden, of Rising Sun, for special favors; to Dr. Sale, of Dillsborough, Mr. B. North, of Ohio county, Messrs. John Gill, John Shroder and Armstrong, of Vevay, and very many others.

To. Dr. G. Sutton, of Aurora, and Mr. C. G. Boerner, of Vevay, I am indebted for many kind favors, besides their additions to the report, which will be found in another part of this volume.